A Framework for telerobotics across the time delays of space

Completed Technology Project (2011 - 2012)

Project Introduction

The proposal will develop a novel intelligent time-delay mitigation framework to be used in bilateral space telerobotics. This framework will consist of master (human) and slave (remote site robot) controllers and adaptive predictors developed for operation in the presence of time delay. The end product will lead the way for an "Avatar"-like telepresence in space, providing reliable and stable tactile feedback to the human user.

Adaptive Posicast Control (APC) is designed for systems with input time delays. In prior work by co-I Yildiz and colleagues (Automatica, IEEE Transactions on Control Systems Technology, Control Engineering Practice) for automotive powertrain controls, APC delivered considerable performance improvements over the current standard non-adaptive, non-delay-compensating controllers. In this proposal APC will be implemented for the first time, as the controller for haptic (i.e., force) feedback regulation in a telerobotic system. This proposal will address the problem of time-delayed force reflection in the system, developed by PI Soloway and co-workers at NASA LaRC. Communication delays, the principal destabilizing factor in teleoperation, will be mitigated by the APC's time-delay compensation capability. Uncertainties such as actuator degradation, parameter changes due to temperature variation and component aging will be handled by the APC's ability to adapt to parametric uncertainties. The power of this intelligent time delay compensation framework will be demonstrated on a simplified bilateral experimental teleoperation testbed, where a virtual slave manipulator will be developed in simulation and a force reflecting joystick will be used as the master. Unlike earlier system identification methods such as extended Kalman Filter approaches, this approach does not need a rich input (persistent excitation) for parameter convergence and unlike passivity based approaches, this approach has explicit time delay compensation which has the potential to provide better performance.

Anticipated Benefits

N/A

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

Center Innovation Fund: ARC CIF

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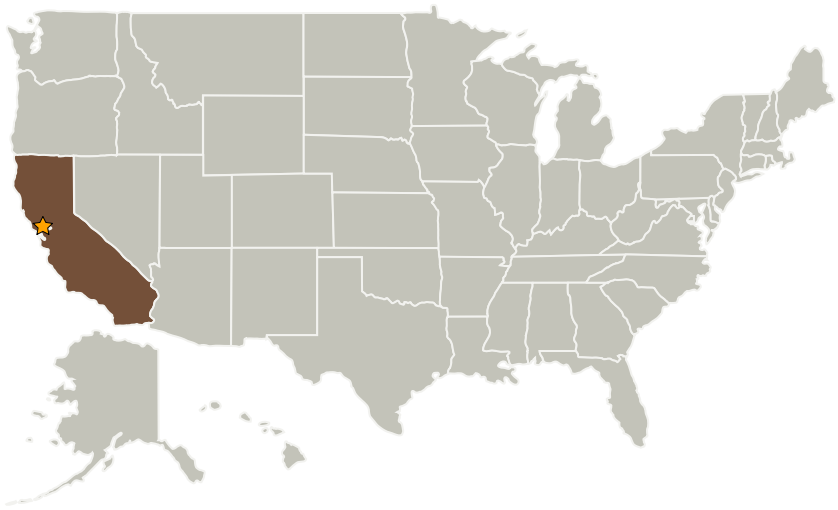
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
California

Stories

1676 Approval #17536
(https://techport.nasa.gov/file/8737)

Project Management

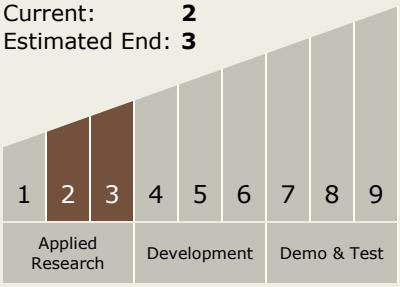
Program Director:
Michael R Lapointe

Program Manager:
Harry Partridge

Principal Investigator:
Donald I Soloway

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.4 Human-Robot Interaction
    - TX04.4.3 Remote Interaction